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CITATION:

Yoshiike, Yutaka. PHYSIOLOGIC STUDIES ON THE VISCERAL SENSATION OF THE UROGENITAL ORGANS. 日本外科宝函 1954, 23(5): 433-444

ISSUE DATE:

1954-09-01

URL:

http://hdl.handle.net/2433/206126

日本外科寶函 第23巻 第5号
ARCHIV FÜR JAPANISCHE CHIRURGIE
XXIII. BAND, 5. HEFT, 1. SEP. 1954.

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PHYSIOLOGIC STUDIES ON THE VISCERAL SENSATION OF THE UROGENITAL ORGANS.

by

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[Received for Publication on July 20, 1954]

INTRODUCTION

The impulses of visceral pain from the urogenital organs are believed to enter the spinal cord between the ninth thoracic and fourth sacral segments, but because of the lack of white rami between the second lumbar and the second sacral segments, those afferents are classified into two groups, i.e. the thoraco-lumbar and the sacral pathways.

Recently, CHUJI KIMURA and KAZUMASA OHBA have discovered a method of causing visceral pain in human beings : injection of vagostigmin (eserin), acetylcholin (A. C.) solution into the wall of the alimentary canal. So, as stimulus to a viscus, I used this A. C. - method as well as other stimuli, such as electric faradization. These investigations were made during laparotomies or cystoscopic examinations under local or spinal anesthesia. We had two factors to consider :

1. The site of referred pain
2. Diminution or disappearance of visceral sensation or its referred pain after anesthesia at certain spinal segments. Furthermore, for experimental studies of sensory nervous pathways in animals, we need objective, observable and constant indicators. Therefore, I used as indicators the visceromotor reflex, vasomotor responses, change of respiration etc.

We had to examine whether the results of the A. C. method were caused by local visceral stimulation.

I. Studies in human beings

The stimuli used were :

(1) electric faradization (4 Volt, 10-20cm, 3-5sec.) (2) injection of A. C. (0.1 g. 2-4cc.) 0.5cc. into the wall of the viscus.

The results of experiments :

.) Visceral sensations of the uterus and the vagina.

Injection of A. C. solution into the uterine muscles caused definite contraction in 7 cases, but in other cases difinite contraction did not appear.

Patients complained of colic or stretch-like pain after a few seconds, and this pain continued for one to five minutes.

Table 1. shows pain and the site of feeling.

Table 1. Abdominal pain, nausea and vomiting following stimulation of uterus in clinical cases.

No. of case. Age	Level of anesthesia	Stimulus	Pain	Site of feeling	Nausea and vomiting
(1) 37	Th 7	Vag-A. C. 25mg	+	Epigastrium	+
(2) 38	Th 10	〃	+	Above the umbilicus	+
(3) 22	Th 9	〃	±	Above the pubis	−
(4) 64	Local anesthesia	〃	+	Hypogastrium	−
(5) 20	Th 7	〃	+	Hypogastrium	+
(6) 59	Th 10	〃	±	Epigastrium	+
(7) 37	Th 9	〃	+	Epigastrium	+
(8) 29	Th 7	〃	+	Hypogastrium	−
(9) 20	Th 9	〃	−		−
(10) 21	Local anesthesia	〃	−		−
(11) 42	Local anesthesia	〃	+	Hypogastrium	−
(12) 22	Th 10	〃	+	Hypogastrium	+
(13) 47	Th 9	〃	±	Hypogastrium	−
(14) 36	Th 9	〃	+	Hypogastrium	−
(15) 26	Th 10	〃	+	Epigastrium	−
(16) 33	Th 10	〃	+	Hypogastrium	−
(17) 42	Th 10	〃	+	Hypogastrium	−
(18) 58	Th 9	〃	−		−
(19) 24	Th 9	〃	±	Hypogastrium	−
(20) 27	Th 9	〃	−		−
(21) 24	Th 10	〃	−		−
(22) 42	Th 10	〃	±	Hypogastrium	−
(23) 26	Th 11	〃	+	Hypogastrium	−
(24) 29	Th 9	〃	+	Epigastrium	+
(25) 29	Th 10	〃	±	Hypogastrium	−
(26) 27	Th 11	Vag-A.C. 12mg	−		+

(1) In 20 of 26 cases pain was felt close to the midline of the abdomen and the epigastrium innervated by nerves T8-T12, especially T11-T12. (Fig. 1) Under spinal anesthesia over the dermatoma of T10, the patients still felt pain. Sensations of stimulation of the vagina were felt in the pubic region (L1-S2).

(2) Nausea and vomiting occured in 8 cases. The reason is that spinal anesthesia itself may cause nausea and vomiting, and that the nausea may be partly due to the vagomimetic stimulus of the A. C. absorbed into the blood.

B) Visceral sensations of the ovary and the Fallopian tube.

Instead of injection of A. C., injection of 0.85% NaCl solution 1cc into the parenchyma of the ovary did not cause pain. Table 2. shows pain and the site of feeling. In 9 of 12 cases constricting dull pain was felt in an area just below and to the injected side of the umbilicus or in the corresponding loin (T10-T11).

Table 2. Pain following stimulation of the ovary and the Fallopian tube in clinical cases.

No. of case. Age	Level of anesthesia	Stimulus	Pain	Site of feeling
(1) 20	Th 10	Vag-A.C. into the parenchyma of the ovary (r)	−	
(2) 32	Th 10	〃 (r)	+	Loin (r)
(3) 12	Th 8	〃 (r)	+	Below the umbilicus (r)
(4) 19	Th 9	〃 (r)	+	Below the umbilicus (r)
(5) 21	Th 11	〃 (r)	+	Loin (r)
(6) 38	Local anesthesia	〃 (r)	−	
(7) 26	Th 6	〃 (r)	+	Below the umbilicus (r)
(8) 42	Local anesthesia	〃 (l)	+	Below the umbilicus (l)
(9) 35	Th 10	〃 (l)	−	
(10) 46	Th 10	〃 (l)	÷	Below the umbilicus (l)
(11) 24	Th 11	〃 (r)	+	Below the umbilicus (r)
(12) 23	Th 11	〃 (r)	+	Loin (r)
(13) 57	Th 9	Vag-A.C. into the wall of the Fallopian tube (r)	÷	Below the umbilicus (r)
(14) 42	Local anesthesia	〃 (l)	÷	Below the umbilicus (l)
(15) 20	Th 10	〃 (r)	+	Below the umbilicus (r)
(16) 12	Th 8	〃 (r)	÷	Below the umbilicus (r)
(17) 21	Th 11	〃 (r)	+	Loin (r)
(18) 16	Th 10	〃 (r)	+	Below the umbilicus (r)

+ : Pain positive　　− : No pain　　÷ : Uncomfortable feeling

(Fig. 1) One patient complained of the pain "as if it were the pain of labour." However, in cats not long before parturition, contraction of uterine muscles never occurred with injection of A.C. into the ovary. Probably the patient complained of labour-like pain because the site of the referred pain in the loin from the ovary bore some resemblance to pain at the beginning of labour.

Under spinal anesthesia over the dermatoma of T 10, the patients still felt pain. Pain of the Fallopian tube was felt in the same area as from the ovary, but slight.

C) Visceral sensations of the spermatic cord and the testicle.

Table 3. shows pain and the site of feeling.

(1) 3 patients with injection of A. C. did not feel pain. Electric faradization of

Table 3. Pain following stimulation of the spermatic cord and the testicle in clinical case.

No. of case. Age	Level of anesthesia	Stimulus	Pain	Site of feeling
(1) 20	Local anesthesia	Faradic stimulation of the spermatic cord a. near the testicle b. in the inguinal canal.	+	a. Suprainguinal region b. Penis
(2) 25	S2	〃 a. b.	+	a. Suprainguinal region b. Penis
(3) 43	Local anesthesia	〃 a.	+	above the pubis
(4) 27	Local anesthesia	before pubis near the external ring	+	Testicle
(5) 40	Local anesthesia	〃 a.	+	a. Suprainguinal region b. Perineum
(6) 53	Local anesthesia	〃 a.	+	above the pubis
(7) 33	Th 10	Compression of the testicle	−	
(8) 20	Th 10	〃	−	

(9) 33	Th 10	Compression of the testicle	−	
(10) 47	Th 11	〃 (r)	+	Hypogastrium (r)
(11) 54	Th 11	〃 (l)	÷	Hypogastrium (l)
〃	Th 12	1) Compression of the testicle (l) 2) Vag.A.C. into the parenchyma of the testicle	+ +	Suprainguinal region (l) below the umbilicus (l)
〃	L 1	Compression of the testicle (l)	+	Suprainguinal region (l)
(12) 54	L 5	〃	÷	Testicle
(13) 25	S 2	〃 (l)	+	Hypogastrium (l)
(14) 20	S 2	〃 (r)	+	Above the pubis (r)
(15) 38	S 3	〃 (r)	+	Scrotum (r)
(16) 41		Violent compression	+	Above the pubis
(17) 20	Local anesthesia	Vag-A.C. into the parenchyma of the testicle (r)	+	Hypogastrium (r)
(18) 53	Local anesthesia	(r)	−	

the spermatic cord which was exposed under local infiltrated anethesia caused sharp pain. The visceral sensation of the spermatic cord from the epididymis to the external ring produced referred pain in the suprainguinal region (T12-L1) while in the portion between the external ring and prostate gland the pain was referred to the penis or to the perineum (S2-S3). (Fig. 2)

Under spinal anesthesia over the dermatoma of T10 or T11, pain never appeared.

(2) The compression of the testicle at the scrotum under spinal anesthesia of the sacral segments caused pain in the abdomen just below and to the stimulated side of the umbilicus (T10-T11), or specially in the suprainguinal region (T12-L1). Under spinal anesthesia over the dermatoma of T10, pain never appeared.

D) Visceral sensatons of the urinary bladder.

Injection of A. C. solution into the bladder muscles caused partial or complete contraction. Patients complained of drawing or stretch-like pain. Table 4. shows pain and the site of feeling. With the A. C. - method pain was felt especially in the

Table 4. Pain following stimulation of the urinary bladder in clinical cases.

No. of case.	Age and Sex	Level of anesthesia	Stimulus	Pain	Site of feeling	Sensation of desire for micturition
(1)	30F	Local anesthesia	Vag-A.C. into the dome	÷	Above the umbilicus	
(2)	32F	Local anesthesia	〃	+	Above the pubis	
(3)	25M	Local anesthesia	〃	+	Suprapubic region (r)	
(4)	27F	Th 11	〃	÷	not clear	
(5)	43F	Th 9	〃	÷	Hypogastrium	
(6)	33M	Th 10	〃	+	Suprapubic region (r)	
(7)	56M	Th 6	Vag-A.C. into the posterior wall	+	Hypogastrium and the penis	
(8)	44M	S 3	Faradic stimulation to the trigone	+	Penis	−
(9)	27M	S 3	〃	+	Suprapubic region and the penis	−
(10)	47M	Th 12	〃	÷	Hypogastrium	−
(11)	53M	S 3	Cauterization in the trigone	+	Penis	+
(12)	43M	S 3	Cautrization in the dome	−		−
(13)	45M	Th 11	Filling the bladder	÷	Above the pubis	−
(14)	54M	Th 11	〃	÷	〃	−

(15) 38M	L 3	Filling the bladder	+	Above the pubis	−
(16) 41F	S 2	〃	+	〃	−
(17) 53M	S 2	〃	+	〃	−
(18) 38F	S 2	〃	+	〃	−
(19) 48F	incomplete	〃	+	〃	+
(20) 21M	incomplete	〃	+	〃	+
(21) 30M	incomplete	〃	+	〃	+

site close to the midline of the abdomen above the pubis (T11-T12), in the supra-inguinal region (L1), above the umbilicus (T9), or in the penis (S2). (Fig. 3) When A. C. solution was injected into the lateral wall of the urinary bladder, the site of pain on the suprapubic region was felt on the stimulated side. Under spinal anesthesia over the dermatoma of T10, the patients still felt pain.

A 33 year old male (No.6 of Table 4) who had a total transverse spinal lesion below T10 by trauma was injected A. C. into the wall of the urinary bladder during laparotomy. He felt severe pain in the suprapubic region.

Electric faradization of the trigone during cystoscopic examinations caused sharp pain referred to the penis and suprapubic region (S2) or to the abdomen (T11) (1 case). (Fig. 3) Under spinal anesthesia over the dermatoma of T12, pain diminished. There was suprapubic pain after filling the bladder with 200cc or more of water. The sensation of desire for micturition on filling the bladder or cystoscopic manipulation disappeared after complete sacral anesthesia.

E) Visceral sensations of the ureter and the kidney.

Table 5. shows pain and the site of feeling.

Table 5. Pain following stimulation of the ureter and the kidney in clinical cases.

No.of case.	Age and Sex	Level of anesthesia	Stimulus	Pain	Site of feeling	Sensation of micturition
(1)	44M	Local Anesthesia	Faradic Stimulation of the upper half of the ureter (l)	+	Penis and the thigh (l)	−
(2)	21M	Local Anesthesia	〃 (r)	+	Suprainguinal region (r)	−
(3)	27M	Local Anesthesia	〃 (r)	+	Urinary bladder	−
(4)	40M	Th 8	〃 (r)	−		−
(5)	53M	Th 9	〃 (l)	−		−
(6)	38M	Th 10	〃 (l)	−		−
(7)	52M	incomplete	〃 (l)	−		+
(8)	41M	incomplete	〃 (r)	+	Loin (r)	−
(9)	25F	incomplete	〃 (l)	+	Below the umbilicus and the penis (l)	−
(10)	47M	Th 12	Faradic stimulation of the lower half of the ureter (r)	−		−
(11)	27M	S 1	〃 (l)	+	Suprapubic region (l)	−
(12)	19F	S 1	〃 (l)	±	Suprapubic region (l)	−
(13)	43M	S 2	〃 (l)	+	Suprainguinal region (l)	−
(14)	44M	S 3	〃 (r)	+	Penis	−
(15)	21M	incomplete	Injection into healthy ureter (l)	+	The costovertebral angle (l)	
〃	〃		Into ureter with stone at the upper part (r)	+	Loin (r)	
(16)	30F		Into healthy ureter (l)	+	The costovertebral angle (l)	

(16) 30F		Into ureter with stricture by retroperitoneal tumor (r)	+	Suprainguinal region (r)
(17) 27M	S 1	Into healthy ureter (r)	−	
〃	〃	Into ureter with stone in the kidney (l)	+	Suprainguinal region (l)
(18) 19F	S 1	Into healthy ureter (l)	+	The costovertebral angle (l)
〃	〃	Into ureter with ren mobilis (r)	+	Loin (r)
(19) 44M	S 2	Into bifid ureter at the lower part (r)	+	Suprapubic region (r)

(1) 4 patients with injection of A. C. into the upper half of the exposed ureter did not feel pain, but one of them felt desire for micturition. Electric faradization of the upper half of the exposed ureter caused sharp pain in the suprainguinal region, the loin, the anterior surface of the thigh, or below the umbilicus on the side stimulated (T11-L2).

Three patients complained of pain referred to the penis or of desire for micturition (S2). (Fig. 4) Under spinal anesthesia over the dermatoma of T10, pain never appeared.

(2) Electric faradization of the lower half of the ureter during cystoscopic examination caused sharp pain homolaterally in the suprapubic or suprainguinal region (L1) under sacral anesthesia, and one patient under anesthesia over the dermatoma of S3 felt pain referred to the penis (S2) (Fig. 4).

The stimulation of the upper part caused a desire for micturition suggesting that the ureter receives sacral sensory nervous supply far more extensively than has been as yet described, but electric faradization of the lower half under sacral anesthesia never caused the sensation of desire for micturition.

(3) Faradic stimulation of the exposed renal capsule and injection of A. C. solution into the renal parenchyma were not painful. However, pain occured at about the region of the outer tip of the 12th rib on the same side (T9-T10) with faradic stimulation of the perirenal fascia, the renal pelvis, or the isolated renal artery. Table 5. shows pain and the site of feeling, when the ureter or the renal pelvis was distended by rapid injection of 7cc or more of Sugiuron solution (59.5% iodine solution) during retrograde pyelography. Filling the healthy ureter without stricture caused pain in the back on the same side. The pain may be due to the distention of the renal pelvis. There was pain in the suprainguinal region, the loin, or the suprapubic region after filling the diseased ureter with Sugiuron. In one patients, who had complained of pain in the area at about the outer tip of the 12th rib or of nausea, the same location of pain and nausea followed filling of the ureter with Sugiuron. These complaints disappeared after the stripping of the capsule on the same side.

This syndrome should be called "reno-gastric syndrome".

II. **Studies in cats.**

The stimuli used were :

(1) electric faradization (2 Volt, 10-15cm, 5-10sec.),

(2) injection of A. C. (0.1g. 5cc) 0.1cc into the wall of the viscus.

Results of experiments :

A) esting the A. C. - method to determine whether the reaction was caused by local visceral stimulation, or by vagomimetic stimulus of the A. C. absorbed into the blood.

(1) Crying and avoiding reaction.

6-12 seconds after injection of A. C. into the wall of the viscus, cats cried and struggled to avoid, and the injected site of the uterus or the bladder wall became spastic. Faradic stimuli caused almost the same changes.

With injection of the same quantity of 0.85 % NaCl solution or vagostigmin these changes never appeared. However, the cats cried even with injection of A. C. into the rectus muscle or kidney parenchyma which in man never caused pain.

(2) Pupilio-dilator reflex.

Even with injection of A. C. into the rectus muscle cat's pupil dilated and they cried.

(3) Changes of respiration.

The changes of respiration were recorded on a kymogram directly. With injection of A. C. into the wall of the viscus, the curve of respiration showed apnea, superficial or deep respiration, or hyperpnea. Other stimuli caused almost the same changes of respiration. (Fig. 5)

However, even injection into the rectus muscle caused almost the same changes.

(4) Vasomoter response.

I measured the blood pressure through a carotid artery.

When A. C. was injected into the wall of the viscus, the blood pressure increased temporarily, and then rapidly decreased. (Fig. 6) With injection of the same quantity of 0.85 % NaCl solution or eserin these changes never appeared. Electric stimulation increased the blood pressure in general. Injection of A. C. into a vein or rectus muscle caused decreased blood pressure. (Fig. 7) In a spinal cat which was decapitated above C3, this vasopressor reation was completely abolished. (Fig. 8)

(5) Visceromotor reflex.

Decerebrated cats were employed (SHERINGTON's method).

The contraction of the abdominal rectus muscle was shown by diagram by Miller's method. Injection of A. C. into the wall of the viscus caused clonic contraction of the abdominal muscles, which gradually rose to a maximum and then declined slowly. Electric stimulation was followed by clonic contraction which gradually declined. (Fig. 9) These results of the A. C. - method, such as increase of blood pressure, dilatation of pupils, etc., which resemble those following electric stimulation, should be considered as noci-reflexes caused by noci-stimuli. Among these reflex phenomena, the vasomotor response should be considered the clearest phenomenon that indicates either the results of local visceral stimulation, or of vagomimetic stimulus due to A. C. absorbed into the blood.

B) Vasomotor response following visceral stimulation after various levels of denervation.

(1) Injection of A. C. solution into the uterine muscles did not cause definite con-

traction, but did cause cats to cry and the blood pressure to increase in 6 of 8 cases. (Fig. 6) The results of the experiments on vasomoter response after various levels of denervation are shown in table 6. In the groups which had sacral, thoraco-lumbar or thoraco-lumbosacral denervation, the blood pressure still increased in a few cases. (Fig. 10) In a pregnant cat with thoraco-lumbosacral denervation, injection of 5 unit of pituitrin caused groaning at intervals. (Fig. 11)

Table 6. Vasomotor response following visceral stimulation of the uterus after various levels of denervation.

Case	Type and level of denervation.	Result
(1) 2.8kg cat	Posterior rhizotomy (L6……S3)	−
(2) 3.0kg cat	Posterior rhizotomy (L6……S3)	±
(3) 2.5kg cat	Posterior rhizotomy (L6……S3)	−
(4) 2.2kg cat	Posterior rhizotomy (L5……S3)	+
(5) 2.8kg cat	Transection of lower lumbar cord (L5……6)	±
(6) 3.5kg cat	Transection of lower lumbar cord (L4……5)	−
(7) 3.2kg cat	Transection of lower lumbar cord (L5……6)	−
(8) 3.7kg cat	Transection of lower lumbar cord (L4……5)	+
(9) 2.0kg cat	Transection of lower lumbar cord (L5……6)	±
(10) 2.2kg cat	Transection of lower lumbar cord (L5……6)	−
(11) 4.3kg cat	1) Posterior rhizotomy (Th10……L1) 2) Presacral neurectomy	+
(12) 2.5kg cat	1) Posterior rhizotomy (Th10……L1) 2) Presacral neurectomy	±
(13) 3.2kg cat	Posterior rhizotomy (Th10……L3)	+
(14) 2.5kg cat	Presacral neurectomy	±
(15) 3.3kg cat	Presacral neurectomy	±
(16) 3.0kg cat	Presacral neurectomy	−
(17) 5.0kg dog	Presacral neurectomy	+
(18) 2.0kg cat	Splanchnectomy	±
(19) 2.3kg cat	Transection of lower thoracic cord (Th9……10)	−
(20) 4.3kg cat	1) Transection of lower thoratic cord (Th10…11) 2) Presacral neurectomy	+
(21) 2.2kg cat	1) Transection of lower lumbar cord (L5…6) 2) Presacral neurectomy	±

(2) Injection of A. C. solution into the ovary, compression or faradic stimulation of the ovary, caused cats to cry and the blood pressure to increase in 4 of 5 cases. (Fig. 12)

The results of the experiments on vasomotor response after various levels of denervation are shown in table 7. In the group with sacral denervation the blood pressure increased in 4 of 5 cases. (Fig. 13) In the group with thoraco-lumbar or thoraco-lumbosacral denervation, the blood pressure increased in only one of 4 cases. (Fig. 14)

(3) Compression or faradic stimulation of the testicle at the tunica vaginalis propria testis caused increased blood pressure, but injection of A. C. solution into the parenchyma of the testicle caused only a slight reaction. (Fig. 15) In a cat with transection of the spinal cord at the level of L5-6 to cause sacral denervation, this vasopressor reaction was indeterminate following various stimulations. (Fig. 16)

Table 7. Vasomotor response following visceral stimulation of the ovary after various levels of denervation.

Case	Type and level of denervation	Result
(1) 2.5kg cat	Posterior rhizotomy (L6……S3)	÷
(2) 2.2kg cat	Posterior rhizotomy (L5……S3)	+
(3) 3.2kg cat	Transection of lower lumbar cord (L5……6)	+
(4) 3.7kg cat	Transection of lower lumbar cord (L4……5)	+
(5) 2.2kg cat	Transection of lower lumbar cord (L5……6)	+
(6) 4.3kg cat	Posterior rhizotomy (Th10……L1)	+
(7) 3.2kg cat	Posterior rhizotomy (Th10……L3)	−
(8) 2.0kg cat	Splanchnectomy	−
(9) 2.3kg cat	Transection of lower thoracic cord (Th9……10)	÷

+ : Vasopressor reaction was perceived. − : No vasopressor reaction. ÷ : Indeterminate

(4) Injection of A. C. solution into the bladder muscle or electric stimulation caused contlaction at the stimulated side or in the whole bladder, and the blood pressure increased. (Fig. 17) The neck of the bladder was more sensitive to faradic stimuli. The results of the experiments on vasomotor response after denervation at various levels are shown in table 8. In 3 of 8 cases with sacral and in 5 of 7 cases with thoraco-lumbar denervation, the blood pressure increased. (Fig. 18, 19) In the group with thoracolumbosacral denervation, this vasopressor reaction was indeterminate, but compression of the bladder caused two cats to cry.

Table 8. Vasomotor response following visceral stimulation of the bladder after various levels of denervation.

Case	Type and level of denervation	Result
(1) 3.0kg cat	Posterior rhizotomy (L6……S3)	−
(2) 2.2kg cat	Posterior rhizotomy (L5……S3)	+
(3) 2.5kg cat	Posterior rhizotomy (L6……S3)	−
(4) 2.8kg cat	Transection of lower lumbar cord (L5……6)	÷
(5) 3.7kg cat	Transection of lower lumbar cord (L4……5)	÷
(6) 2.2kg cat	Transection of lower lumbar cord (L5……6)	−
(7) 3.8kg eat	Transection of lower lumbar cord (L5……6)	+
(8) 2.0kg cat	Transection of lower lumbar card (L5……6)	+
(9) 4.3kg cat	1) Posterior rhizotomy (Th10……L1) 2) Presacral neurectomy	+
(10) 3.2kg cat	Posterior rhizotomy (Th10……L3)	+
(11) 2.5kg cat	Posterior rhizotomy (Th10……L3)	−
(12) 2.5kg cat	Presacral neurectomy	÷
(13) 3.3kg cat	Presacral neurectomy	+
(14) 3.0kg cat	Presacral neurectomy	+
(15) 2.0kg cat	Splanchnectomy	+
(16) 2.3kg cat	Transection of lower thoracic cord (Th9……10)	÷
(17) 4.3kg cat	1) Transection of lower thoracic cord (Th10…11) 2) Presacral neurectomy	÷
(18) 2.2kg cat	1) Transection of lower lumbar card (L5…6) 2) Presacral neurectomy	−

(5) In a cat with transection of the spinal cord at the level of L5-6 to cause sacral denervation, faradic stimulation of the lower part of the ureter abolished the vasopressor reaction, but stimulation of the upper part increased the blood pressure. After sacral denervation, stimulation of the uterus, bladder or testicle diminished the vasopressor reaction more than after thoraco-lumbar denervation. Stimulation of the ovary after thoraco-lumbar denervation abolished or diminished this reaction, but after sacral denervation it was perceptible. However, stimulation of these urogenital visci after thoracolumbar denervation or sacral denervation still caused vasopressor reaction or other noci-reflexes in a few cases.

SUMMARY

1. Injection of A. C. solution into a urogenital viscus such as uterus, ovary, tube or urinary bladder caused visceral dull pain which was still felt under spinal anesthesia over the dermatoma of T 10. Electric stimulation of the spermatic cord or the ureter caused referred sharp pain which disappeared under spinal anesthesia over the dermatoma of T 10.

2. Sites of feeling following stimulation of various urogenital organs shows that sensory innervation of these organs is chiefly thoracolumbar, and that the vagina, ureter, trigone of urinary bladder and spermatic cord between the external ring and the prostate is innervated by the sacral nerves.

3. In cats and dogs injection of A. C. solution into the visci caused various reflex phenomena as noci-reflexes. Even injection into the rectus muscle or vein caused these reflex phenomena. While injection of A. C. solution into a viscus caused temporary increase of blood pressure, injection into a vein caused decreased blood pressure. This vasopressor reaction is considered to be a reaction to local visceral stimulation, and was completely abolished in the spinal cat.

4. In cats the vasopressor reaction and other noci-reflexes caused by various types of stimulation of the urogenital organs after denervation shows that sensory innervation of these organs in cats is thoraco-lumbar and sacral, and that the ovary is dominantly innervated by thoraco-lumbar nerves and in other organs sacral innervation is more or less dominant.

I am much indebted to Assist. Prof. Ch. Kimura, M. D. of our clinic for his constant help throughout my study. This was read by him as a part of his paper "Surgery of the Autonomic Nervous System" at the 51. Annual Meeting of the Japanese Surgical Association, on April 1-3. 1951, Tokyo.

Bibliography

1) Adson, A. W., and Masson, J. C.: Dysmenorrhea relieved by resection of presacral sympathetic nerves. Jour. Am. Med. Assn. **102**, 986. 1934. 2) Asai, Sh.: Naizo chikaku no nijyu shinkei shihai hosoku. Kyoto Igaku Zasshi, **23**, 518, 669, 1925. 3) Balchum, O. J., and Weaver, H. M. : Pathways for pain from the stomach of the dog. Arch. Neurol. Psychiat., **49**, 739, 1943. 4) Bors, E. : Perception of gonadal pain in paraplegic patients. Arch. Neurol. Psychiat., **63**, 5, 713, 1950. 5) Cannon, B. : A method of stimulating autonomic nerves in the unanesthetized cat with observations on the motor and sensory effects. Am. J. Physiol., **105**, 366, 1933. 6) Cleland, J. P. G. : Paravertebral anesthesia in obstetrics : Experimental and clinical basis. Surg. Gynec. and Obst., **57**, 51, 1933. 7) Davis, L., Pollock, L. J., and Stone, T.T. : Visceral pain. Surg. Gynec. and Obst., **55**, 418, 1952. 8) Elaut-L. : The surgical anatomy of the so-called pre,

sacral nerve. Surg. Gynec, and Obst., **55**, 581, 1932. 9) Evans, J. P. : Observations on the nerves of supply to the bladder and urethra of the cat, with a study of their action potentials. J. Physiol., **86**, 396, 1936. 10) Foerster, O. : Die Leitungs-bahnen des Schmerzgefühls und die chirurgische Behandlung der Schmerzzustände, 360 pp. 1927. 11) Fontaine, R., and Herrmann, L. G. : Clinical and experimental basis for surgery of the pelvic sympathetic nerves in gynecology. Surg. Gynec. and Obst., **54**, 133, 1932. 12) Hatcher, R. A., and Weiss, S. : Studies on vomiting. J. Pharm. Exp. Therap., **22**, 139, 1924. 13) Ingersoll, F. M., and Meigs, J.V. : Presacral neurectomy for dysmenorrhea. New Eng. Jour. Med., 238, 11, 357, 1948. 14) Kaida, W. : Igaku Kenkyu, **21**, 5, 32, 1951. 15) Kimura, C. : The problems of abdominal pain. Arch. für japanische Chirurgie, **22**, 59, 1953. 16) Kuntz, A. Autonomic nervous system. 687, 1945. 17) Kure, T. and Okinaka, Sh. : Jiritsu shinkei-kei 1949. 18) Kuru, M. : On the pelvic equivalent of the sensory vagus. Japan. Jour. Physiol., **1**, 3, 1951. 19) Mc Lellan, A. M., and Goodell, H. : Pain from the bladder, ureter, and kidney pelvis. Proc. Assn. for Res. In Nerv. and Ment. Diss., **23**, 252, 1942. 20) Mitchell, G. A. G. The innervation of the kidney, ureter, testicle, and epididymis. J. Anat., **70**, 10, 1935. 21) Nesbit, R. M., and Mc Lellan, F.C. ; Sympathectomy for the relief of vesical spasm and pain resulting from intractable bladder infection. Surg. Gynec. and Obst., **68**, 540, 1939. 22) Nozuhara, H. : Igaku, Kenkyu **21**, 5, 71, 1951. 23) Ranson, S. W. : New evidence in favor of a chief vasoconstrictor center in the brain. Studies in vasomotor reflex arcs. Ⅳ. Am. J. Physiol., **42**, 1, 1, 1916. 24) Ranson, S. W. : Afferent spinal paths and the vasomotor reflexes. Studies in vasomotor reflex arcs. Ⅵ. Ibid., **42**, 1, 16, 1916. 25) Ray, B. S., and Neil, C, M.: Abdominal visceral sensation in man. Ann. Surg., **126**, 709, 1947. 26) Sheehan, D., The autonomic nervous system. Annual Rev. Physiol., **3**. 399, 1941. 27) White, J, C., and Smithwick, R. H. : The autonomic nervous system. 469 pp. 1941. 28) Woolard, H. H., and Carmichael. E. A.: The testis and referred pain. Brain, **56**, 293, 1933.

Explanation of Figures.

Fig. 1. The site of feeling of abdominal pain from the uterus and ovary by A. C. - method.

Fig. 2. a. The site of referred pain from spermatic cord or testicle by electric stimulation or compression.
b. The site of referred pain from the urinary bladder by various stimulations.

Fig. 3. The site of referred pain from the ureter (and the pelvis of kidney) by electric stimulation or rapid injection of Sugiuron (iodine solution).

Fig. 4. Respiration curve
a. A.C. (2.5mg) injected into the uterus of cats.
b. Electric stimulation (2 Volt 10 cm) of the wall of the ovary.

Fig. 5. Temporary increase of blood pressure, followed by decrease, when A. C. 2.5mg was injected in the wall of the uterus of a cat.

Fig. 6. a. Decrease of blood pressure, when A. C. 2.5mg was injected into the rectus muscle of a cat.
b. No. change of blood pressure, when eserin 0.1cc was injected into the wall of the uterus of a cat.

Fig. 7. No increase of blood pressure of a spinal cat, following injection of A. C. 5mg into the wall of the ileum (a) and electric stimulation (2 Volt 10 cm) of the neck of the urinary bladder (b).

Fig. 8. Visceromotor reflex of decerebrate cat following injection of A.C. 5 mg into the wall of urinary bladder (a.) and electric stimulation (2 Volt 10 cm) of the uterus (b.)

Fig. 9. Slight increase of blood pressure in a cat with section of posterior roots (L6···S3) followed by decrease, when A. C. 5 mg was injected into the uterus.

Fig. 10. When 5 units of pituitrin was injected into the uterus of a pregnant cat at term, blood pressure increased and cat groaned at intervals.

Fig. 11. Increase of blood pressure of a dog, when A. C. 2.5 mg was injected into the parenchyma of the ovary.

Fig. 12. Temporary increase of blood pressure.
a. When A. C. 2.5 mg was injected into the parenchyma of the ovary of a cat with transection of the lower lumbar cord (L5···6).
b. Compression of the ovary of a cat with section of posterior roots (L5···S3).

Fig. 13. a. Slight increase of blood pressure of a cat with transection of the lower thoracic cord (Th9···10), when A. C. 1.2 mg was injected into the parenchyma of the ovary.
b. No change of blood pressure of a cat with section of posterior roots (Th10···L1) following compression of the ovary.

Fig. 14. a. Increase of blood pressure of a cat caused by compression of the testicle at tunica vaginalis propria testis.

b. Slight increase of blood pressure of a cat, when A. C. 2.5 mg was injected into the parenchyma of a testicle.

Fig. 15. No change of blood pressure of a cat with transection of the lower lumbar cord (L5…6) following injection of A. C. 7 mg into the parenchyma of a testicle (a), and compression of the testicle at the tunica vaginalis propria testis (b).

Fig. 16. Increase of blood pressure of a cat caused by injection of A. C. 2.5mg into the wall of the urinary bladder (a), and electric stimulation (2 Volt 10cm) of the neck of the urinary bladder (b).

Fig. 17. No change of blood pressure of a cat with section of posterior roots (L6…S3) following injection of A. C. 1.2mg into the urinary bladder (a), and electric stimulation (2 Volt 0 cm) of the neck of the urinary bladder (b).
Increase of blood pressure following electric stimulation (2 Volt 10 cm) of neck of the urinary bladder. (c).

Fig. 18. a. Slight increase of blood pressure of a cat with presacral neurectomy, followed by decrease, when A. C. 1.2 mg was injected into the urinary bladder.
b. Increase of blood pressure of a cat with section of posterior roots (Th10…L1) caused by electric stimulation (2 Volt 10 cm) of the neck of the bladder.

和 文 抄 録

泌尿生殖器管に於ける内臓知覺の生理學的研究

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吉 池 裕

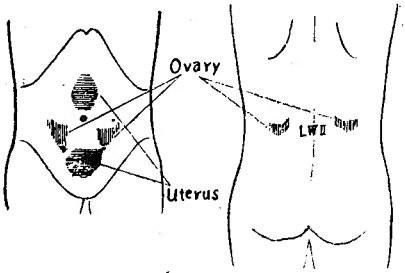
(1) 人体及び猫の泌尿生殖器各臓器に A. C. 法を行い，又従来刺戟法として用いられている感応電気刺戟及び機械的刺戟を行い，その際の疼痛の有無，疼痛感受部位を観察し，動物に於いては，A. C. 法の結果が果して刺戟局所の反応と理解し得るや否やを吟味し，又神経切断実験により血圧上昇反応，その他の侵害反射の有無を観察し，之等の臓器知覚が胸腰域或は仙髄域いづれの脊髄断区に属するかを決定せんとした．

(2) A. C. 法により子宮，卵巣，輸卵管，膀胱，睾丸に於て夫々痛みを起すことが出来た．輸精管，輸尿管，腎臓に於いては痛みを起すことが出来なかつた．感応電気刺戟による痛みは関聯痛であり，A. C. 法による痛みは関聯痛の他に真の内臓痛も存する様であり，脊椎麻酔による Th, 10 或はそれ以上の麻痺の後尚痛みがある．

(3) 各種刺戟による疼痛感受部位より観察すれば，人体泌尿生殖器系内臓痛覚は主として胸腰性支配を受けて居り，腟，輸精管前立腺嚢り，膀胱3角部，輸尿管に於いて仙髄性支配が認められるにすぎない．

(4) A. C. を筋肉内或は静脈内に注入した対照に就いて各種侵害反射を検査した際と，臓器内注入の場合の反応とで殆ど差を認め難い．血圧反応ではその間に差が認められ，その一過性の血圧上昇反応は局所刺戟による反応と考えられる．此の血圧上昇反応を指標とし，他の侵害反射を参考として内臓知覚路を検討した．

(5) 血圧上昇反応を指標とした際，猫に於ける泌尿生殖器系内臓知覚支配は，子宮，卵巣，膀胱，睾丸の諸臓器では胸腰性，仙髄性の2重支配が認められ，卵巣では胸腰性が断然優勢であり，他は仙髄性が多少優勢であると考えられる．



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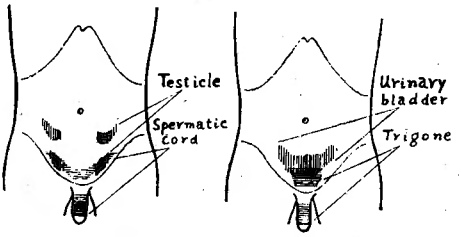


Fig. 2

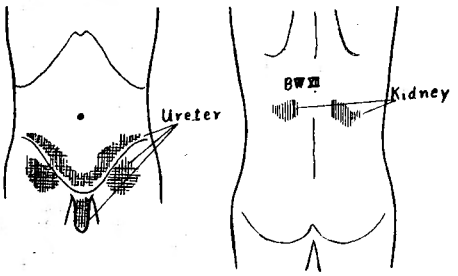
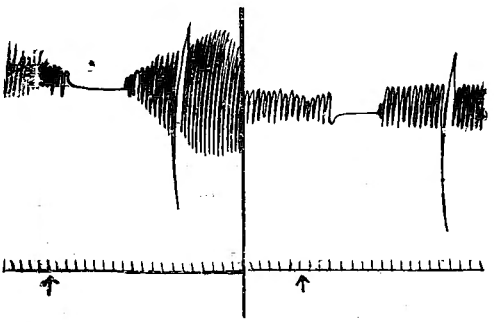


Fig. 3



a Fig. 4 b

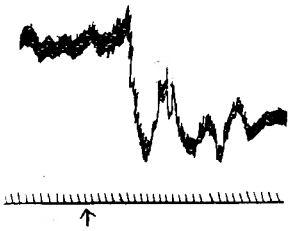


Fig. 5

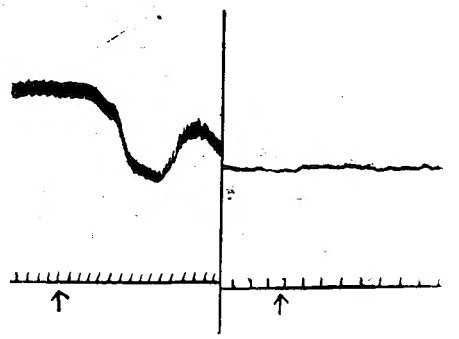


Fig. 6

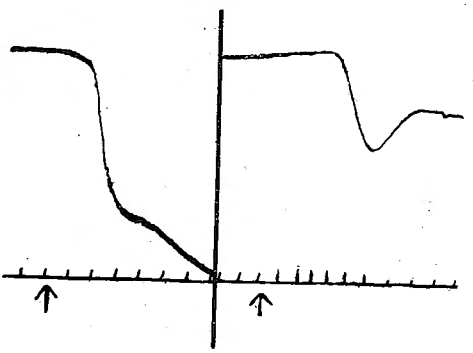


Fig. 7

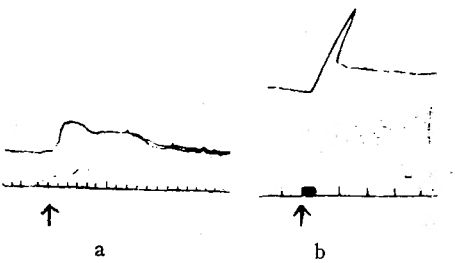


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Fig. 8

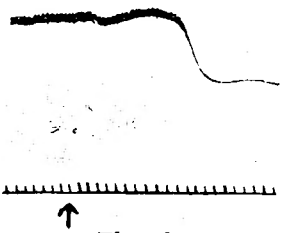


Fig. 9

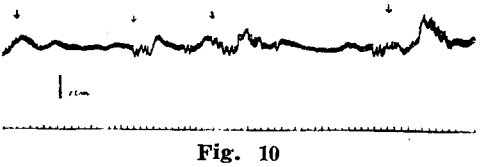


Fig. 10

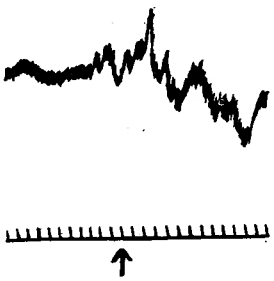
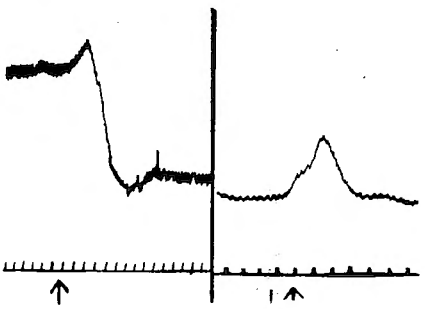
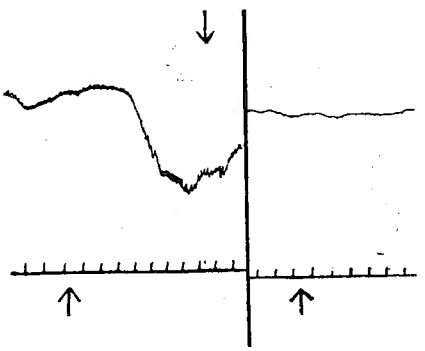


Fig. 11



a Fig. 12 b



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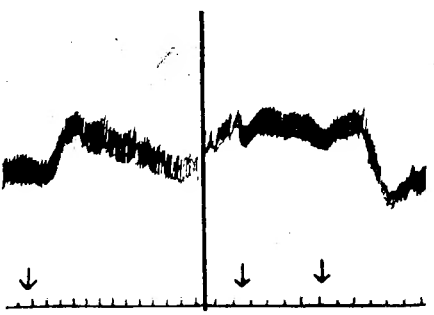

a Fig. 14 b

a b

Fig. 15

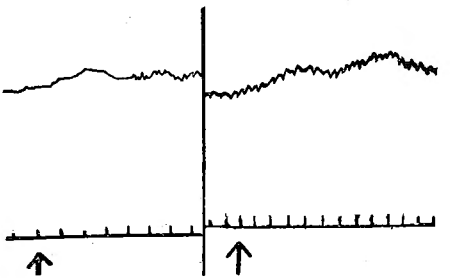

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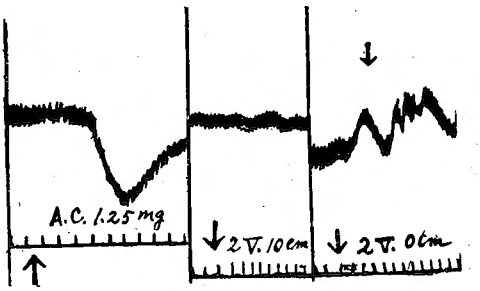
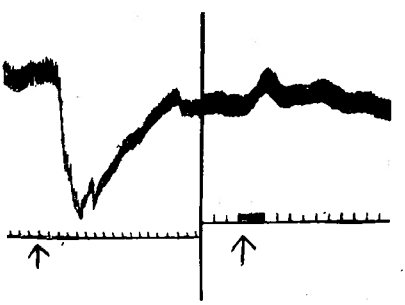
Fig. 16



a b c

Fig .17



a Fig. 18 b